

GROUND WATER QUALITY ASSESSMENT NEAR MUNICIPAL SOLID WASTE DUMPING SITE, SOLAPUR, MAHARASHTRA, INDIA

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ABSTRACT

Municipal Solid Waste (MSW) involves the flow of solid waste generated by households, commercial developments, industries and institutions. Inadequate or improper management and disposal have serious consequences for the environment and human health. Improper management of MSW leads to many serious problems including ground water contamination. All major sites in developing countries are facing the problems of municipal solid waste management. Municipal waste disposal sites pose serious environmental threats to their surroundings and nearby resident due to contamination, pollution problems and health risks.

In present investigation, water samples were collected in the study area during pre- monsoon and post- monsoon season from January to April 2012 and September to December 2012 and were analyzed for parameters includes pH, Turbidity, Hardness, Total Dissolved Solids, fluoride, Chloride, Sulphate, Nitrate, MPN etc. The results of collected water samples for both seasons show that the ground water is not potable within WHO guidelines, particularly in post monsoon season due to high bacterial contamination that may result in many waterborne diseases and other environmental problems.

KEYWORDS: Groundwater, Microbial Contamination, Leachate, Seasonal Variation, Water Pollution, Water Quality

INTRODUCTION

The generation of solid waste is not new phenomenon. It is directly related to human civilization. The first organized dump of solid waste is reported to have been set up outside the Athens in 500 B.C. (Krushnmoorthy, 2001). The problems associated with solid waste management in all major cities of developing countries are more acute than in the major cities of developed countries. The rapid growth in population and urbanization, adds greatly to the volume of waste being generated in the cities which also adds to the demand for waste retrieval service in municipal areas. On the other hand, an increase in population is not matched with an equal increase in revenue for the municipal authorities for proper waste management (Zerboc, 2003).

Water is essential for all living organisms. Everything is originated from water and everything is dependent on water for them. If the solid waste sites are not managed properly may cause surface water pollution and ground water pollution, also adds to air pollution, soil contamination, odor nuisance, disease causing vector, nuisance etc. The landfills and municipal disposal sites have a greater possibility of ground water pollution around the solid waste disposal sites because, the lechate originates from the decomposition of the organic wastes disposed at these sites and finally percolate into the local aquifers. Such contamination of groundwater resource poses a substantial risk to local

resource users and surrounding environment. In rainy season, the water gets mixed into the waste and most of the chemicals and decompositions of materials dissolve in water and starts leaching. This leachate creates the problem of ground water contamination (Chavan and Zambare, 2013).

STUDY AREA

Solapur city is located at $17^{\circ}41'N$ $75^{\circ}55'E$ $17.68^{\circ}N$ $75.92^{\circ}E$. It is situated on Deccan plateau. It has an average elevation of 458 meters from mean sea level. It is situated in southern part of Maharashtra and found to be strategically positioned vis-a-vis Karnataka & Andhra Pradesh States. The Solapur city has evolved as the regional growth centre, attracting economic activities and providing livelihood to large in-migrating population. It is famous for its small and medium scale industries, mainly for cotton mills and power looms. It is well known as the Textile Capital for making the good quality of bed sheets which have become famous and internationally reputed for their novel designs and durability (SCSP, 2011). The Solapur city and district has scanty and no uniform rains, resulting in scarcity conditions in the entire district. This has adversely affected the socio-economic condition of regional people. In order to face this situation, the Ujani dam is built to provide drinking water to city dwellers and water for irrigation to rural draught prone areas. Groundwater is also tapped for domestic and irrigation in some parts of Solapur especially in summer season. The quality of groundwater is questionable in some areas near the solid dumping sites which constituted the base for present investigation.

Climate

Solapur falls under the category of arid and semiarid climate according to the Koppen climate classification (<http://en.wikipedia.org/wiki/>) The city experiences the all seasons like summer, monsoon and winter. The summer starts from month of March to May, with maximum temperature ranging from 30 to $40^{\circ}C$ (86 to $104^{\circ}F$). The warmest months in Solapur are April and May. The monsoon lasts from the end of June to the end of September, with moderate rainfall. The city of Solapur receives an average rainfall of 545 mm per year. Winter begins in November and last until the end of February with the temperatures occasionally dropping below $10^{\circ}C$ ($50^{\circ}F$). The temperature is widespread in different geographical areas in the entire Solapur district (Chavan and Zambare, 2013).

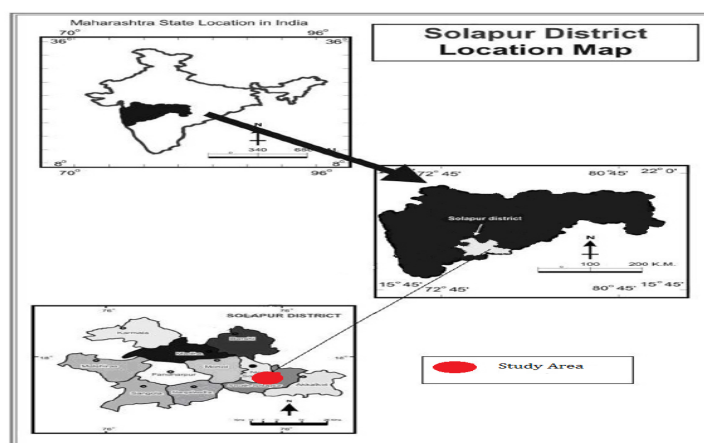


Figure 1a: Map of Solapur City

The solid waste dumping sites in Solapur are located near the city area at about 7 Km. near the Tuljapur road where from groundwater samples were collected for the present study. The water sampling locations are presented in Figure 1a.

SAMPLING AND ANALYSIS

Water samples were collected from the study area during pre- monsoon and post- monsoon seasons, from January to April 2012 and September to December 2012 to assess the possible scenario of ground water contamination caused by solid waste leachate formed by waste dumping. Six samples were collected from around the dump site in glass bottles. Water samples were analyzed by using standard methods (Aliyu, 2010; Maity, *et.al.*, 2013 and APHA, 1989). Parameters analyzed were pH, Turbidity, Hardness, Total Dissolved Solids, Conductivity, Fluoride, Chloride, Sulphate, Nitrate, MPN etc.

Table 1: Average characteristics of Water Samples from Different Study Locations (Pre- Monsoon) in Comparison with the Permissible Limits (WHO. 1971)*

Sr. No.	Parameters	(WHO, 1971)*	(W1)	(W2)	(W3)	(W4)	(W5)	(W6)
1	pH	6.5-9.2	7.8	7	6.7	7.2	6.9	7.1
2	Turbidity(NTU)	5 NTU	4.74	3.12	4.98	5.21	3.87	4.31
3	Hardness (mg/L)	600	680	367	521	634	520	309
4	Conductivity (μ S/cm)	---	1123	756	692	671	765	566
5	TDS (mg/L)	< 1000	986	465	554	307	417	341
6	Fluoride (mg/L)	1.0 – 1.5	1.2	1.1	0.91	0.76	1.2	1.05
7	Chloride(mg/L)	200 - 600	145	82	81	93	98	103
8	Sulphate(mg/L)	200 - 400	175	122	134	176	163	117
9	Nitrate(mg/L)	45	13	23	22	18	13	19
10	MPN/100 ml	Nil	21	23	10	11	13	17

Table 2: Average Characteristics of Water Samples from Different Study Locations (Post- Monsoon) in Comparison with the Permissible Limits (WHO. 1971)*

Sr. No.	Parameters	(WHO, 1971)*	(W1)	(W2)	(W3)	(W4)	(W5)	(W6)
1	pH	6.5- 8.5	6.9	6.7	6.9	7.1	6.8	7.0
2	Turbidity(NTU)	5 NTU	4.92	6.78	4.3	7.14	8.12	6.43
3	Hardness (mg/L)	600	567	315	532	430	540	326
4	Conductivity (μ S/cm)	---	1534	943	895	674	1098	689
5	TDS (mg/L)	< 1000	1045	665	627	546	452	542
6	Fluoride (mg/L)	1.0 – 1.5	1.3	0.92	0.98	0.78	1.2	1.08
7	Chloride(mg/L)	200 - 600	176	86	95	102	122	117
8	Sulphate (mg/L)	200 - 400	181	143	154	114	114	113
9	Nitrate(mg/L)	45	34	26	12	12	23	19
10	MPN/100 ml	Nil	185	197	81	98	112	148

RESULTS AND DISCUSSIONS

The analysis of water parameters exhibits certain variations from sample to sample. The characteristics of the collected water samples are shown in table 1 and 2.

pH

It is used to express the intensity of acidic or alkaline condition of the solution. At all six sampling stations pH values were found in within desirable limits and suitable range. The pH values of all collected water samples in Pre monsoon season ranged between 6.7 to 7.8 and in post monsoon the pH values were found slightly acidic in well W1, W2, W3 and W5 were slightly acidic due to the leachate contamination.

Turbidity

The values for turbidity were found to be exceeding the WHO limits at four sampling sites in post monsoon season, 8.12 NTU at W5, 7.14 NTU at W4, 6.78 NTU at W2, and 6.43 NTU at W6 and 8.69 NT (Table.2). During pre monsoon all turbidity values were within the limits of WHO. The exceeded limits for turbidity especially in post monsoon season exhibit the presence of pollutants in the ground water which might be due to the leachate percolation.

Total Hardness

Total hardness was found to be within the prescribed limit of WHO (1971) except at W1 where it ranged 680 mg/L and W4 634 mg/L in pre monsoon and post monsoon respectively. This is probably due to the closeness of the sample site to the landfill, thus making the water unfit for certain domestic uses.

Conductivity

Conductivity is a valuable indicator of the amount of the materials dissolved in water. The conductivity in the study area ranged between 671(μ S/cm) to 1534(μ S/cm) in both seasons. These high conductivity values obtained at W1 in post monsoon that is closest to landfill indicate the effect of landfill on water quality in form of leachate outcome and inorganic pollution at this specific site.

Total Dissolved Solids (TDS)

Total Dissolved Solids (TDS) as shown in Table No. 1 and 2 ranged between 307 mg/L to 1045 mg/L in both seasons. In post monsoon season, the all TDS values are increased in post monsoon season as compared with pre monsoon. The increasing value of TDS shows that, the contamination of groundwater due to leachate comes from the solid waste dumping site. However, the increasing values of TDS also increased the conductivity values.

Fluoride

Fluoride content in higher concentration in water causes teeth mottling (Sudhir Dahiya; 1999). The study conducted reveal that fluoride content ranged between 1.2 mg/L to 1.1 mg/L in both the seasons respectively. In post monsoon season it was found slightly higher, but within permissible limit prescribed by WHO.

Chloride

Chloride content in ground water may result from both, natural and anthropogenic sources such as run-off containing salts, the use of inorganic fertilizers, landfill leachate, septic tank effluents, animal feeds, and seawater invasion in coastal areas. Chloride is not harmful to human at low concentration, but could alter the taste of water at concentration above 250 mg/L (Trivedi and *et.al.*, 1986). The values of chloride in pre monsoon season were in the range of 81 mg/L to 145 mg/L. In post monsoon season the amount of chloride were increased in all locations due to leachate contamination. In both seasons the chloride values were found within the permissible limit of WHO.

Sulphate

Sulphate is a nontoxic anion but ailment like catharsis, dehydration and gastrointestinal irritation have been linked with it's when concentration is high (Bertram, J. *et.al.*, 1996, Hauser, 2001). The amount of sulphate in pre monsoon season was ranged 122 mg/L to 175 mg/L. In post monsoon the values of sulphate were increased in all groundwater

sampling sites and these values were ranged between 113 mg/L to 181 mg/L. The increase in concentration of sulphate in post monsoon season shows that the contamination of groundwater due to the leachate from the solid waste disposal sites.

Nitrate

The nitrate content in both seasons at sampling sites was within permissible limit and it is ranged between 26mg/L to 12 mg/L presented in (Table No. 1 and 2). The concentration of nitrate was increased in post monsoon due to leachate contamination. The increasing concentration of nitrate shows that there are chances of increasing problem of pollution in future. In post monsoon the values of nitrate were ranged between 12 mg/L to 34 mg/L which indicate that the well water quality in the study area has no potential impact in terms of blue baby syndrome (Chavan *et.al.*, 2013).

MPN

The microbiological analysis of the water samples showed that significant amount of organic matter is present in ground water at all sample sites which provided nutrition for the growth and multiplication of microorganisms. Present results of microbiological examination shows that, the water samples in pre-monsoon and post- monsoon seasons were significantly high ranges particularly in post monsoon season thus exceeding WHO limits (Table No.2).

The results showed that the collected samples do not meet the WHO limits for bacteriological characteristics that must be zero count per 100ml but all the samples were exceeded values of MPN in all samples in post monsoon season indicate the contamination of ground water by leachate. The percolation of leachate has greatly affected the ground water quality particularly in post monsoon season because of heavy summer monsoon rains thus by increasing the health risks (Butt, *et.al.*, 2012).

CONCLUSIONS

The seasonal variations are noticeable in the concentration above mentioned parameters with high values of TDS, Conductivity, Turbidity, Chloride, Sulphate and Nitrate more in post monsoon season than in pre monsoon season and are the major indications of water pollution. Heavy bacterial contamination within the study area is observed during post monsoon season when heavy rains of summer monsoons accelerate the leachate production and leaching into subsoil.

It can be concluded that the poor practices of waste management carried out at Municipal Solid Waste Dumping site at Solapur city site and the absence of leachate collection system has a great impact on the ground water quality. It is suggested that the concerned authorities should take serious steps for the control of ground water pollution by providing base of cement concrete to insure for the safety of local environment and public health. They are advised to use improved techniques of solid waste management, leachate collection and ground water monitoring on regular basis.

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